TENOTOMY OF THE INFERIOR OBLIQUE*

JOHN HUGHES DUNNINGTON, M.D.
New York

Tenotomy of the inferior oblique is supposed to have been done first about the middle of the eighteenth century by John Taylor,[1] a quack, who, posing as an oculist, traveled the continent of Europe curing squints by some mysterious procedure. He is thought to have made a conjunctival incision at the lower inner part of the globe and to have passed his scissors through this opening in such a manner that one blade was kept in contact with the floor of the orbit sufficiently far back to include the inferior oblique, which he divided by closing the blades of the scissors. This is a surmise, however, since his operative procedure was kept secret.

The first description of this operation is that by Bonnet,[2] who, in 1841, in his "Traite des Sections Tendineuses et Musculaires," published a complete account of his technique, indications, and results. His interest in this subject had been stimulated by the research of Jules Guerin on the treatment of high myopia by tenotomy of the lateral recti muscles, and by Phillips' suggestion that tenotomy of the superior oblique might be beneficial in these cases. These men were all convinced that high myopia was directly the result of the venous stasis produced by the pressure the extra-ocular muscles exerted upon the globe. Bonnet conceived the idea that most of the compression was caused by the inferior oblique, and after experimenting on albino rabbit and cadaver eyes became convinced of the truth of his notion. He then tenotomized the inferior oblique on the

* Candidate's thesis for membership accepted by the Committee on Theses.

living, and reported several cases in which, following this operation, considerable improvement of vision was obtained. Five of these cases also had "la disposition à la fatigué des yeux," which completely disappeared after severance of the inferior oblique. This observation prompted him to tenotomize both inferior obliques in a case of asthenopia without myopia and complete relief was obtained. He then tried the procedure on two cases of nystagmus, but came to the conclusion that unless the operation had a good effect on the cause of the nystagmus, nothing would be accomplished; and cited a case of congenital myopia with nystagmus reported by Roux de Meximieux, in which cutting both inferior oblique muscles benefited the myopia and stopped the oscillations.

After this work of Bonnet no further mention of the operation appeared until 1885, when Landolt[3] called attention to the surgical accessibility of the origin of this muscle, and described an accurate technique for its severance as well as outlining indications for its use. He thought this operation might be useful in paralysis of the superior oblique, in paralysis of the inferior rectus, and in progressive myopia, and believed the field for its greatest usefulness would be in the treatment of malignant myopia, saying, in this connection, "who knows whether the operation which is the subject of our article will not some day acquire a more important significance and receive a more extended application." Although he made these definite recommendations no evidence is furnished that he ever actually performed this operation on a living subject. We do not find another reference to tenotomy of the inferior oblique until 1906, when Duane[4] reported his results with this operation in certain types of ocular muscle paralysis. In the following year Posey[5] reported its successful use in five cases of congenital paresis of the superior rectus. This article of Duane, however, remained unpublished, except for a brief statement of

the indications, until 1915, when Posey,[6] with Duane's permission, incorporated its salient features in his comprehensive paper on this subject.

INDICATIONS

In spite of Bonnet's enthusiastic approval of tenotomy of the inferior oblique for malignant myopia, this operation never became popular and has long since been entirely discarded.

The use of this procedure in nystagmus has been limited to those cases reported by Bonnet and his confrères, since their results were not satisfactory. Nor did Landolt's definite suggestions find favor, for not until Posey's report of Duane's precise work, revealing the rationale of its use in certain ocular muscle paralysis, did wide-spread interest in this operation become manifest. Since the appearance of this article many observers, including Howard,[7] White,[8] Parker,[9] Todd,[10] Carson,[11] and others, have recorded their experiences with tenotomy of the inferior oblique, and their case reports have substantiated Duane's observations that this operation is useful in the following types of ocular muscle paralyses:

(1) Paralysis* of the superior rectus of one eye with or without spasm of the inferior oblique of the opposite eye.

(2) Paralysis of the superior oblique with secondary spasm of the inferior oblique of the same eye.

(3) Paralysis of the external rectus with compensatory spasm of the inferior oblique in the same eye.

Before proceeding with a discussion of these types of muscle paralysis in which this operation is employed, it is well to review the methods by which an exact diagnosis of paralysis can be made. An accurate measurement of the amount of the deviation in the six cardinal directions of

* The term "paralysis" is used in this article to denote all degrees of underaction, i. e., from a slight insufficiency to a complete paralysis.

gaze by the screen and parallax test, along with a careful plotting of the diplopia fields in these six directions, will determine whether the deviation is paretic, and if so, what muscle or muscles are affected. Duane's repeated insistence on the necessity of careful use of these tests and on the futility of attempting to diagnose slight paralyses without them has led to their more or less general adoption. While the determination of a correct diagnosis is essential, the symptomatology is equally important, since the mere existence of a muscular deviation is no indication for operation unless the symptoms demand it. Since all these conditions have certain symptoms in common, it is well to consider them at this time. A disfiguring squint, torticollis, and diplopia are the most frequent complaints which we are called upon to correct by operation.

The most common disfiguring vertical squint occurs as a complication of a lateral one, in which the squinting eye is turned in and markedly up. Here the removal of both the lateral and vertical deviations is necessary for a good cosmetic result.

It has been known for a long time that torticollis is associated with vertical ocular imbalance, for in 1858 Graefe[12] mentioned it. However, Cuignet[13] in 1873 was the first to call attention to the correction of these vicious positions of the head by operation on the vertical ocular muscles. Similar case reports were given by Wadsworth[14] and Risley[15] in 1889 and Nieden[16] in 1892, and since that time numerous articles on ocular torticollis have appeared. Landolt's[17] explanation that the position of the head is assumed to avoid a diplopia is now generally accepted. While de Lapersonne[18] agreed with him, he believed that in certain instances the vicious attitudes of the head will persist after removal of the diplopia; however, this is true only in those cases of very long standing where actual changes have taken place in the sternocleidomastoid muscles. As Hübschner[19] has

pointed out, the eyes execute a compensating rotation in the opposite direction to that of the face, and this rotation, by its persistence, brings about a further weakening of the ocular muscles which turn the eyes in the pathologic direction of the face and whose paralysis caused the torticollis.

Diplopia is often a reason for operation; usually, however, it is for the secondary symptoms it causes that we operate. Head tilting, confusion, vertigo and nausea are the most frequent complaints demanding correction. Sometimes it is not possible to abolish a diplopia by operation, but we can succeed in making it more comitant. Two extremely important points to be borne in mind in operating to correct a diplopia are:

(1) A varying diplopia is much more annoying than one that remains more or less the same in all directions of gaze.

(2) A diplopia in the lower fields is more productive of asthenopia than one confined to the upper fields.

A thorough knowledge of the importance of these two points undoubtedly influenced Duane in the formulation of his indications for tenotomy of the inferior oblique. The following detailed discussion of each of these types of ocular muscle paralysis will show the rationale of its use in each instance.

PARALYSIS OF THE SUPERIOR RECTUS

Paralysis of this muscle is quite common, both as a congenital and as an acquired anomaly, and although it occurs in all degrees of severity and from various causes, it is most frequently seen as a congenital insufficiency. Congenital involvement was considered quite rare until 1907, when Posey,[5] in an analysis of 70 cases of congenital ocular muscle paralysis, found the superior rectus involved in 25 of them. This work was followed by Duane's[20] analysis in 1911 of 105 similar cases in which the superior rectus was affected in 54 instances, the inferior rectus in 26, the external rectus in 12,

the superior oblique in 7, the inferior oblique in 5, and the internal rectus in 1. This work was one of Duane's most important contributions, for it established not only the relative frequency of congenital involvement of the various extra-ocular muscles, but also the paralytic nature of many cases formerly regarded as non-paralytic. Prior to the appearance of this article, absence of diplopia was considered a diagnostic feature of congenital paralysis, but Duane proved that diplopia is an almost constant finding in congenital cases and frequently produces a very troublesome confusion.

Congenital paresis of the superior rectus may or may not be associated with spasm of the inferior oblique of the opposite eye, depending upon which eye is used for fixation. If the paretic eye is used for fixation, then the secondary deviation of the other eye, spasm of the inferior oblique, is pronounced, while if the sound eye fixes, it is lacking. These cases are furthermore frequently complicated by a spasm of the inferior rectus of the paretic eye, so White[8] divided them into type 1, those without the spasm of the antagonistic inferior rectus, and type 2, those with the spasm of the antagonistic inferior rectus. The presence or absence of the inferior rectus spasm can be detected by a careful diplopia plotting, and an accurate measurement of the deviation by the screen and parallax test in the upper and lower fields. A comparison of the two appended diplopia fields (figs. 1 and 2) will readily differentiate between the two types. In type 1 (fig. 1) we see practically no diplopia in the lower temporal field but a marked increase in the upper temporal field, while the diplopia plotting of type 2 shows a vertical separation almost as great below as above on the affected side. The deviation will, of course, correspond to the diplopia.

Since diplopia is such a constant finding in congenital paralysis, it is not surprising that we frequently see a head

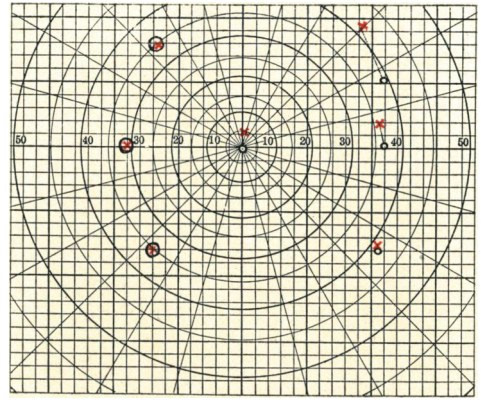

Fig. 1.

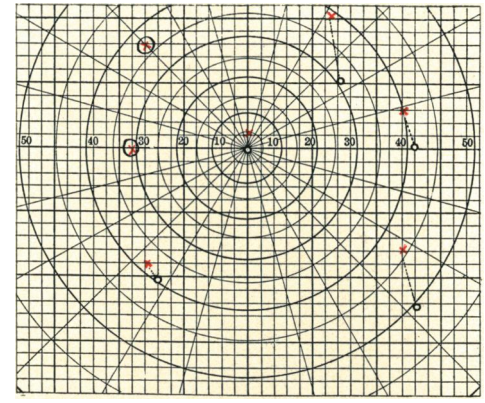

Fig. 2.

Fig. 3.—Usual position of the head and eyes. Note the apparent absence of any vertical strabismus.

Fig. 4.—Marked upshoot of right eye when head is held straight.

tilt or a lateral deviation develop, for nature by one of these methods attempts to rid the patient of the double vision. The two pictures (figs. 3 and 4) show the usual position of this child's head and the position of the eyes when the head is held straight. It illustrates not only the development of a head tilt, but also of an inward deviation from a paresis of the left superior rectus. Cases with a combined vertical and lateral deviation are not uncommon, and although the lateral squint may overshadow the vertical one, the latter must be corrected to effect a permanent cure. If the vertical error is corrected before the lateral deviation is well established, the lateral one frequently disappears without treatment, but if both deviations are pronounced, both will have to be removed. This can be done either in two stages or by a combined operation at one sitting. There are no special features of the cases of acquired paralysis of this muscle, although they are encountered and occasionally have to be treated surgically, in which event the degree of the paralysis is the determining factor in the choice of operation.

With the diagnosis of superior rectus paralysis established and operation decided upon, what procedure can be used?

1. Advancement, resection, or tucking of the paretic muscle.
2. Tenotomy or recession of the antagonistic inferior rectus.
3. Tenotomy of the contralateral inferior oblique.
4. Combination of any two or all three of these procedures.

Landolt[21] strongly advocated advancing the paretic muscle in cases of superior rectus involvement. He reports the successful use of his combination resection and advancement, with no mention of having created a diplopia in the lower field. Duane,[22] on the other hand, finds that with advancement one is very likely to restrict the motility of the inferior rectus and thereby produce a distressing diplopia in its field

of action. This is particularly liable to occur if the inferior rectus is tenotomized at the same time. Another disadvantage to the advancement of the superior rectus is the ptosis produced by this operation, which, while usually only temporary, is alarming. The tendon of the superior rectus is closely connected by fascial bands with that of the levator, hence when the superior rectus contracts it assists in raising the upper lid. If this tendon contracts, as from a tenotomy, the same thing occurs, and, on the contrary, when the muscle and fascial bands are advanced the upper lid is also carried forward and the eye is 1 or 2 mm. less open that its fellow. In one of my cases in which a 7 mm. resection was done, 4 mm. of ptosis were present one week after operation, but four weeks later less than 1 mm. of it remained.

Banister,[23] while agreeing with Duane that an advancement should not be used, has had no ill effects from a tucking of the superior rectus combined with a controlled tenotomy (recession) of the inferior rectus. He condemned tenotomy of the inferior oblique for these reasons:

"(1) A sound muscle pertaining to a sound eye is sacrificed to compensate for the deficiency in the paralyzed muscle of the affected eye. (2) The inferior oblique is divided at its origin and is definitely paralyzed, so that the effect of its section cannot be regulated." In rebuttal Duane[24] stated that his experience with 150 cases had led him to believe these objections were largely theoretical, and that tenotomy of the inferior oblique is the operation of choice in cases of paralysis of the superior rectus. By sectioning this muscle both eyes are equally limited in this field, and the diplopia and deviation, if not entirely corrected, are made much more comitant. We also have very little to fear regarding an overcorrection in the lower fields, such as might easily follow a recession of the inferior rectus. Severance of the inferior oblique is particularly indicated when the diplopia and the deviation are limited to the upper

field, and when the upshoot of the fellow-eye is marked when its gaze is directed inward and upward. In other words, the ideal case for its use is one with congenital paresis of the superior rectus in which the paretic eye is used for fixation, thus causing a marked secondary deviation of the other eye in the form of a spasm of the inferior oblique. The cases with a secondary spasm of the antagonistic inferior rectus may ultimately need a recession of the inferior rectus. Several months, however, should elapse after the tenotomy of the inferior oblique before resorting to it. It is unwise to combine these procedures because the spasm of the inferior rectus may gradually disappear following tenotomy of the inferior oblique.

PARALYSIS OF THE SUPERIOR OBLIQUE

While isolated paralysis of this muscle is fairly common, yet judging from the literature comparatively few cases have been operated upon. Congenital involvement of the superior oblique is quite rare, as evidenced by Duane's[20] finding this mucle affected only seven times in 105 cases of congenital paralysis of the extra-ocular muscles.

The traumatic paralyses are the ones that have most frequently come to operation. However, while injuries to the trochlea are not rare, only a comparatively small number of these cases have been severe enough to demand surgical interference. This is all the more surprising when one considers how extremely annoying is the diplopia produced by a paralysis of this muscle. The technical difficulties precluding the possibility of strengthening the paretic muscle probably account for the many procedures that have been suggested for the correction of this type of ocular muscle paralysis; for in spite of the relative infrequency of the need of such an operation we find (a) tenotomy of the superior rectus, (b) advancement of the inferior rectus, (c) tenotomy of the inferior rectus of the opposite eye, and (d) tenotomy of the

inferior oblique have all been tried. Each one has its adherents, and a study of the literature leaves one in a quandry as to the best operation to employ in incurable paralysis of the superior oblique. Our best decision then will follow an analysis of these proposed procedures.

(a) *Tenotomy of the Superior Rectus.*—Müller[25] and others have reported the satisfactory use of this operation in paralysis of the superior oblique, and while it is the one that has been employed most frequently it cannot succeed completely, because, as Jackson[26] has pointed out, the superior rectus is the principal aid of the superior oblique in producing intorsion. Hence, although tenotomy of this muscle turns the eye down, it makes matters worse as far as extorsion is concerned. Furthermore, the upward movement of the eye is now dependent upon the action of the inferior oblique, which acting more strongly increases the extorsion. To overcome this difficulty, Jackson suggested first division of all but the most temporal fibers and later a transplantation of the tendon of the superior rectus backward and outward. By this method he weakened the upward pull of this muscle but increased its intorting effect. He[27] has reported the successful use of this method in three cases.

(b) *Advancement of the Inferior Rectus.*—E. Landolt[28] was a strong advocate of this method of treatment and insisted that in spite of the theoretical objections to it satisfactory results could be obtained by its use. He believed that strengthening the other depressor would largely compensate for the underactive superior oblique. Eperon[29] in 1889 reported the successful use of this operation in a case of traumatic paralysis of this nature, and Stanculeanu[30] in 1902 also placed on record two such cases satisfactorily corrected by Landolt by the use of this method. It is difficult to conceive how an advancement of the inferior rectus could materially change the downward motility in the nasal field, for when the eye is turned in this direction that muscle has

very little depressing effect. It would also appear that its use would increase, if anything, the extorsion of the eye. These objections must have some weight, for in spite of Landolt's insistence it is not in general adoption, and Uchida[31] is the only author who has recently suggested its use.

(c) *Tenotomy of the Inferior Rectus of the Opposite Eye.*—Wells[32] in 1860 was the first to advocate this method of handling paralysis of the superior oblique. He argued that since these two muscles are associated in their action, a paralysis of one calls for a weakening of the other. A few years later von Graefe,[33] Runeberg,[34] and Kries[35] also used this same method of treatment. Landolt[28] thought this operation would limit the downward gaze to such an extent that any use of the eyes in this field would be well-nigh impossible, and condemned its use with such vigor that it was practically discarded until Duane,[36] realizing the rationale of Wells' suggestion, advocated its adoption. This author said that since "the parallelism of action of the superior oblique of one eye and the inferior rectus of the other holds good for all directions of the gaze this operation affords complete compensation for the paralysis." Duane was always careful not to disturb the lateral attachments of the muscle, and after Jameson[37] revived our interest in recession, advocated its use in place of tenotomy. Banister[23] employs what he calls a controlled tenotomy, which is in reality a recession without scleral anchorage. These men therefore teach us that recession of the contralateral inferior rectus is the operation most commonly employed in paralysis of the superior oblique.

(d) *Tenotomy of the Inferior Oblique.*—Although Landolt[3] in 1885 suggested tenotomy of the inferior oblique for paralysis of the superior oblique, Duane[4] in 1906 was the first to describe his results with this operation in this type of muscular paralysis. Duane[38] has observed that in some

cases of paralysis of the superior oblique there is a marked overaction of the inferior oblique in the same eye, as shown by a decided upshoot of the eye in adduction. He subsequently found that when this spasm is pronounced, tenotomy of the inferior oblique is likely to produce marked improvement. Posey,[5] in his analysis of twenty-one cases on which tenotomy of the inferior oblique was done, found this indication present only once, although Duane in discussing this paper recorded two such cases. White's[8] series of fifty cases of spasm of the inferior oblique contains but four of this type. Snell[39] reported the cure of a case of traumatic paralysis of the superior oblique by tenotomy of the inferior oblique after a severance of the superior rectus had been unsuccessful. Since this operation should not be done unless a secondary spasm of the inferior oblique is present, it is limited in its usefulness in this type of paralysis. After tenotomy of the inferior oblique, the paretic superior oblique may partially resume function, so it is wise to wait several weeks until the result is stationary before deciding whether or not a recession of the contralateral inferior rectus is indicated.

PARALYSIS OF THE EXTERNAL RECTUS

Paralysis of the external rectus is another type of ocular muscle paralysis in which spasm of the inferior oblique is prone to occur. Its frequent presence in these cases has led to considerable speculation as to its exact cause. The two reasons most frequently given are:

(1) The inferior oblique being an abductor attempts to compensate for the deficient external rectus and is therefore constantly overstimulated.

(2) The inward deviation of the eye produced by the paralysis of the external rectus places it in the most favorable position for elevation by the inferior oblique.

Neither of these explanations seems sufficient, for when

more abduction is needed, it is logical to assume that nature overstimulates both of the obliques to an equal extent and does not call upon the inferior oblique to the exclusion of the superior; furthermore, the mere placing of an eye in adduction does not predispose to the development of a spasm of the inferior oblique unless there is a disproportion in strength between it and the superior oblique. Therefore it would seem that a spasm of the inferior oblique does not occur in conjunction with an external rectus paralysis unless there is some predisposing vertical imbalance present. This hyperphoria may have been extremely slight and readily overcome until the onset of a horizontal diplopia rendered fusion impossible. The vertical imbalance then becomes progressively worse and manifests itself in the form of a spasm of the inferior oblique. Regardless of the exact etiology, the correction of it by tenotomy of this muscle is the obvious treatment, which, of course, must be combined with the proper operative procedures for correction of the lateral deviation.

TECHNIQUE

Before considering the methods of tenotomy of this muscle it might be well to review a few points in the surgical anatomy. The inferior oblique is usually described as arising from a small, shallow depression on the orbital floor lateral and close to the opening of the nasolacrimal canal, with some fibers frequently coming from the lower part of the fascia covering the lacrimal groove. Whitnall,[40] however, in an examination of 100 orbits, found this origin in only 45 instances, while in 47 of them it was found 2 to 5 mm. lateral to the incisura lacrimalis, and in 8 instances it was as much as 6 or 7 mm. more temporally situated. The scleral insertion is obliquely placed in the lateral and inferior quadrant of the posterior hemisphere, usually about 5.2 mm. from the optic nerve and only 2.2 mm. from a spot corresponding to the fovea. It is also 9.5 mm. posterior to the

insertion of the external rectus and at right angles to it. Its nerve supply, which is from the inferior division of the oculomotor nerve, enters the belly of the muscle about the middle of its hinder border. Whitnall found the insertion higher than usual in 3 of the 8 cases he described with the extremely temporally placed origin. The author has encountered one case in which the origin was at least 5 mm. temporal to its usual site. White[8] has described a two-headed origin in one case—one attachment was normally placed while the other was several millimeters temporal to it.

Bonnet,[2] in his original description of this operation, called attention to the surgical inaccessibility of the insertion of the inferior oblique, and pointed out how much easier it is to sever this muscle at its origin on the floor of the orbit. His technique, while bold and blind, apparently accomplished the desired results with no ill effects. He plunged a sharp tenotome through the skin and subcutaneous tissues overlying the insertion until the blade came in contact with the floor of the orbit, then, being careful to maintain this contact, he pushed the knife backward and inward for a distance of 2 to 3 cm.; the blade was then turned anteriorly and the knife withdrawn in a horizontal direction until the point emerged beneath the skin just temporal to the lacrimal sac. This maneuver he knew must catch the inferior oblique, but to make sure of its section he then directed the blade downward so as to impinge the muscle between the tenotome and the superior maxillary bone and cut it on withdrawal. Evidently most of the ophthalmologists of that time did not agree with Bonnet in the harmlessness of this procedure, for we find no references to the use of his technique other than those quoted in his book, and not until forty-four years later did Landolt[3] publish his method of severing this muscle. This author also pointed out the ease with which tenotomy of the inferior oblique at its origin can be accomplished, and brought to our attention a landmark which is

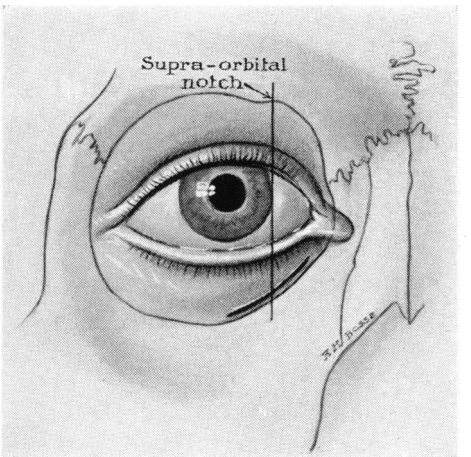

Fig. 5.

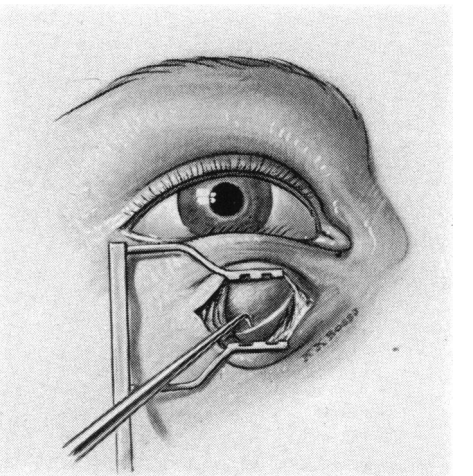

Fig. 6.

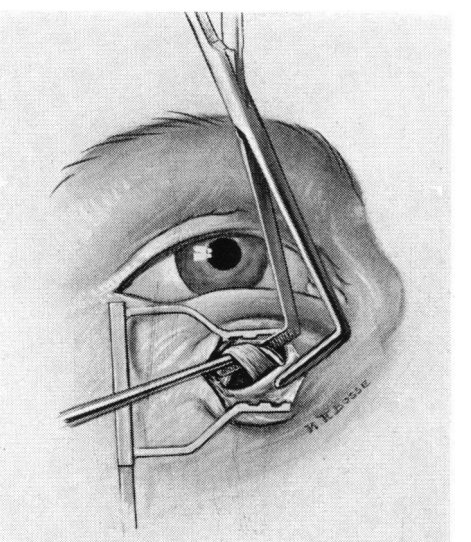

Fig. 7.

very helpful in locating the origin of this muscle under the skin. It is formed by the supra-orbital notch; a perpendicular dropped from this point determines by its intersection with the lower margin of the orbit the skeletal attachment of the muscle. He made a curved incision with its concavity upward through the skin, orbicularis, and orbital septum along the inferior orbital margin in such a way that its center was bisected by the perpendicular from the supra-orbital notch. With this exposure he then engaged the tendon on a strabismus hook and completely severed it close to the bone.

In addition to Landolt's method of approach through a skin incision, which is still the most popular, we have two other feasible routes in tenotomy of the inferior oblique, and these I shall call the conjunctival and the posterior routes. Each of these three methods will be described in detail.

(a) *The Skin Route.*—As previously stated, Landolt made use of the supra-orbital notch as a landmark for locating the origin of the inferior oblique (fig. 5). With this point accurately in mind, an incision 15 to 20 mm. long is made through the skin and the orbicularis along the inferior orbital margin, so that the central point of it is opposite the attachment of the muscle. A lacrimal sac speculum is inserted, and the septum orbitale is then opened for a similar distance. The next step is the picking up of the muscle on the hook, and this is readily accomplished if the following technique is carried out: The hook is entered at the temporal end of the incision with its point in contact with the floor of the orbit (fig. 6) and pushed back into the orbit for 5 mm.; then, being careful to keep the point on the orbital floor, the hook is turned to face nasally and swept up and in. This maneuver necessarily catches the inferior oblique and as it presents it is surrounded by orbital fat and fascia. The muscle is then freed for 6 mm. and clamped with a muscle forceps, and the tendon completely severed between

the clamp and the periosteal attachment as close as possible to the bone (fig. 7). About 3 or 4 mm. of the tendon is then excised to prevent a possible reattachment. The skin wound is closed with interrupted silk sutures and a firm dressing applied. The wound has usually healed sufficiently in four days to permit the removal of the sutures and a discontinuance of the dressing. Considerable swelling and ecchymosis of the lower lid sometimes occur, but readily disappears.

(b) *The Conjunctival Route.*—Instead of making a skin incision, which at times is undesirable, it is possible to tenotomize this muscle at its origin through an opening in the lower conjunctival culdesac. This type of incision has been used for the past ten years at the New York Eye and Ear Infirmary, but the first reference in the literature to its feasibility was made in 1921 by Parker,[9] who simply stated that it was possible to do this operation through a conjunctival incision. To bring the conjunctival culdesac in to view traction sutures are placed through the lower lid and the episcleral tissue of the globe, and an incision 15 mm. long is then made at the bottom of the culdesac and the dissection is directed toward the orbital margin (fig. 8). When this is completed, the muscle is picked up by using the hook in the same way as described in the skin route, and in all other details the two operations are similar. While this method is very useful in certain cases, it is slightly more difficult than the direct skin route, as a larger amount of orbital fat and fascia present with the muscle, which makes it necessary to disturb more of the orbital tissue to free it. Aside from slightly greater reaction, no untoward results have been noted. Usually the skin incision leaves no appreciable scar; however, that possibility is removed by making the incision in the conjunctiva.

(c) *The Posterior Route.*—As clearly stated, spasm of the inferior oblique is commonly associated with lateral strabis-

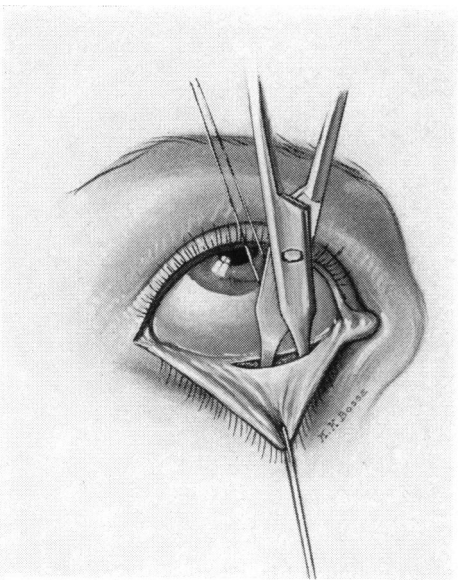

Fig. 8.

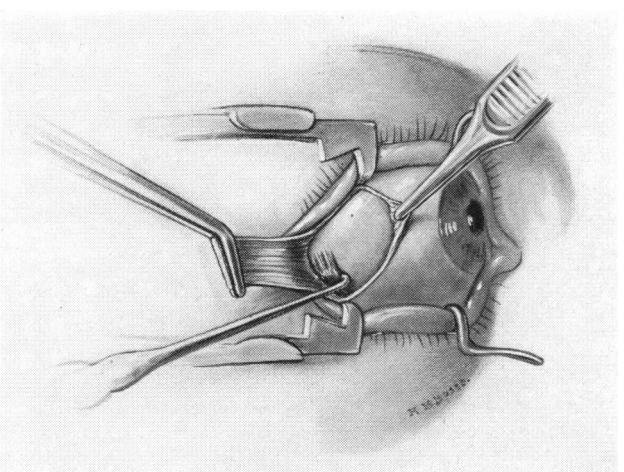

Fig. 9.

mus, and when both conditions are pronounced, a satisfactory and permanent cure can be accomplished only by the removal of the lateral as well as the vertical deviation. In such cases, where the external rectus is to be shortened, I have severed the inferior oblique at its ocular insertion. This is accomplished by first exposing the external rectus in the usual manner, clamping it with the muscle forceps, and completely severing it; then, with the tendon reflected temporally (fig. 9) and the eye rotated sharply inward, a strabismus hook is passed under the inferior oblique and it is completely severed close to its attachment to the sclera. In these cases I have not found it necessary to excise a portion of the muscle. As already stated, the posterior route should be used only in the mixed cases where the combined type of operation is to be recommended. With the external rectus reflected out of the way it is much simpler to tenotomize this muscle at its posterior attachment than to make a second incision through the skin or conjunctiva and sever it at its origin.

RESULTS

As we have outlined the indications and technique of this operation we must now consider the results. The cases reported by the earlier observers show wide variations in the amount of hyperphoria corrected by this method. For example, in Posey's[5] series we find one instance in which the hyperphoria was reduced only 1 centrad, while in another case 17 centrads were corrected by tenotomy of this muscle. The failures were undoubtedly due to a reattachment of the muscle close to its original skeletal insertion. This uncertainty in the amount of correction obtainable by tenotomy led Duane to advocate removing a portion of the muscle, and since the general adoption of this technique the results have been more uniform. As with any operative procedure on the ocular muscles, it is impossible to state that a certain amount of correction will invariably follow an

exsection of the inferior oblique. However, a study of the cases reported shows the average amount of correction to be from 10 to 15▽. White,[8] for example, places 5 to 22▽ as the limits, Howard's average was 6▽, Rowland's,[41] 10▽, while Parker[9] in one case corrected as much as 28▽ by tenectomy of the inferior oblique. From these reports and my own experience, it seems safe to say that by this operation one can expect to remove at least 6▽ of hyperphoria, and usually not more than 20▽. However, it is true that the greatest amount of correction results from its use in those cases where the spasm of the inferior oblique is most marked. So far as is known no serious overcorrection has ever resulted from the removal of a portion of this muscle. There is some limitation of motility upward in the nasal field, but in my experience this operation does not result in a complete paralysis of this muscle. This is probably due to the cut end becoming adherent to the fascial tissue of the orbit in the region of Lockwood's ligament, thereby allowing the muscle to retain some of its function. A complete tenotomy at the insertion in the sclera has also not resulted in a complete loss of power, which must mean that a reattachment to the sclera occurs and probably at a lower level.

CONCLUSIONS

From this study we can conclude that:

1. Tenotomy of the inferior oblique is indicated in:

(a) Paralysis of the superior rectus of one eye, with or without a spasm of the inferior oblique of the opposite eye.

(b) Spasm of the inferior oblique of one eye secondary to a paralysis of the superior oblique or of the external rectus of the same eye.

2. Its use in these conditions is warranted for these reasons:

(a) The diplopia and deviation, if not entirely removed, are made more comitant.

(b) Any resulting limitation of motility or diplopia is confined to the upper fields.

(c) No interference with the action of the depressors can result.

3. Tenotomy of this muscle can be done either at its origin or at its insertion. The former is usually approached through a skin incision, but can be reached easily through an incision in the lower conjunctival culdesac. The scleral attachment is accessible only when the external rectus is reflected out of the way, so tenotomy by the posterior route should be used only in those cases requiring a correction of both the lateral and the vertical deviations.

REFERENCES

1. Am. Encyclop. Ophth., xi, p. 8088.
2. Bonnet: Traite des Sections Tendineuses et Musculaires, 1841, p. 228.
3. Landolt: Arch. d'opht., Sept.–Oct., 1885, p. 402.
4. Duane: Brit. M. J., 1906, Part 2, p. 1867.
5. Posey: Tr. Sect. Ophth., A.M.A., 1907, p. 253.
6. Posey: Tr. Am. Ophth. Soc., xiv, p. 65.
7. Howard: Arch. Ophth., xlix, p. 381.
8. White: New York State J. Med., May, 1920, xx, p. 156.
9. Parker: J. Michigan M. Soc., 1921, xx, p. 313.
10. Todd: Tr. Am. Acad. Ophth. & Oto-Laryn., 1916, p. 173.
11. Carson: Am. J. Ophth., iii, p. 59.
12. Graefe: Motilitätstörungen des Auges, 1858, H. Peters, Berlin, p. 130.
13. Cuignet: Rec. d'opht., 1873, p. 24.
14. Wadsworth: Tr. Am. Ophth. Soc., 1889, p. 381.
15. Risley: Ibid., p. 384.
16. Nieden: Centralb. f. prakt. Augenh., Nov., 1892, p. 321.
17. Landolt: Bull. méd., June 22, 1890, p. 578.
18. de Lapersonne: Arch. d'opht., 1905, xxv, p. 585.
19. Hübschner: Beitr. z. klin. Chir., 1893, x, p. 299.
20. Duane: Tr. Am. Ophth. Soc., xii, p. 981
21. Landolt: Internat. Clin., ii, Series 13, p. 291.
22. Duane: Fuchs' Text Book of Ophthalmology, Ed. 7, p. 946.
23. Bønister: Tr. Am. Acad. Ophth. & Oto-Laryn., 1925, p. 160.
24. Duane: Ibid., p. 176.
25. Müller: Ztschr. f. Augenh., xxv, p. 236.
26. Jackson: Am. Encyclop. Ophth., xi, p. 8238.
27. Jackson: Ophth. Rev., 1903, p. 61.
28. Landolt: Norris and Oliver, System of Diseases of the Eye, iv, p. 69.
29. Eperon: Arch. d'opht., 1889, ix, p. 115.
30. Stanculeanu: Arch. d'opht., 1902, xxii, p. 32.
31. Uchida: Nippon Gankwa Gakukwai Zasshi, Jan., 1914, p. 112.
32. Wells: Roy. Lond. Ophth. Hosp. Rep., 1860, iii, p. 48.
33. von Graefe: Klin. Monatsbl. f. Augenh., 1864, ii, p. 1.
34. Runeberg: Finska läk.-sällsk. handl., 1873, xiv, p. 58.

35. Kries: Arch. f. Ophth., 1878, xxiv, p. 117.
36. Duane: Fuchs' Text Book of Ophthalmology, Ed. 7, p. 950.
37. Jameson: Arch. Ophth., 1922, li, No. 5, p. 421.
38. Duane: Arch. Ophth., 1897, xxvi, p. 325.
39. Snell: Arch. Ophth., 1919, xlviii, p. 111.
40. Whitnall: Anatomy of the Human Orbit, p. 284.
41. Rowland: J. Ophth., Oto. & Laryn., 1928, xxxii, p. 120.

CLINICAL AND EXPERIMENTAL STUDIES ON TRAUMATIC ANNULAR OPACITY OF THE ANTERIOR LENS SURFACE (VOSSIUS' RING)*

JOHN FREDERICK GIPNER, M.D.
Rochester, N. Y.

I. THE NATURE AND ORIGIN OF THE VOSSIUS LESION

General agreement on the nature of Vossius' ring opacity is still lacking even though many observations and experimental studies have been made, the most recent with the slit-lamp and corneal microscope.

Vossius in 1906 described two different changes in the lens which he considered responsible for the appearance of the annular ring. These could exist either singly or associated. He said: "If the ring is of pale brown color and easily demonstrated by focal illumination, it is to be regarded as a pigment deposit on the anterior capsule. The pigment comes from the pars retinalis iridis and is pressed out from the cells of the same consequent to the trauma. Its origin is purely mechanical. If the ring is not seen by focal illumination and appears only in the reflected light of the ophthalmoscope as a finely punctate circle lying in the capsule, then its origin is the result of degenerative changes in the capsular epithelium, or of the anterior layers of the lens, resulting from pressure."

* From the Section on Ophthalmology, Division of Surgery, University of Rochester Medical School. Candidate's thesis for membership accepted by the Committee on Theses.